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臺灣大學應用力學研究所

演 講 公 告

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主 講 人：Prof. Jiun-Shyan Chen (William Prager Chair Professor)
University of California, San Diego Department of Structural Engineering & Department of Mechanical & Aerospace Engineering

講 題：Thermodynamics-based Machine Learning and Data-driven Computing for Inelastic and Fracture Modeling

摘 要： 如附件

主 持 人： 陳發林教授

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Thermodynamics-based Machine Learning and Data-driven Computing for Inelastic and Fracture Modeling

Jiun-Shyan (JS) Chen
Department of Structural Engineering
Department of Mechanical & Aerospace Engineering
University of Californian San Diego, USA

Abstract

Characterization and modeling of complex materials by phenomenological models remains challenging due to difficulties in formulating mathematical expressions and internal state variables (ISVs) governing path-dependent behaviors. Data-driven machine learning models, such as deep neural networks and recurrent neural networks (RNNs), have become viable alternatives. However, pure black-box data-driven models mapping inputs to outputs without considering the underlying physics suffer from unstable and inaccurate generalization performance. This study introduces a machine-learned physics-informed data-driven constitutive modeling approach for path-dependent materials based on the measurable material states. The proposed data-driven constitutive model is designed with the consideration of universal thermodynamics principles, where the ISVs essential to the material path-dependency are inferred automatically from the hidden state of RNNs. For materials subjected to fracturing or strain localization, a neural network enriched “meshfree” Reproducing Kernel Particle Method (RKPM) for capturing weak and strong without re-meshing or mesh adaptation is introduced. In the proposed method, a background reproducing kernel (RK) approximation defined on a coarse and uniform discretization is enriched by a neural network (NN) approximation under a Partition of Unity framework. In the NN approximation, the deep neural network automatically locates and inserts regularized discontinuities in the function space via the energy-based loss function minimization. These unique combinations of machine learning techniques and advanced computational methods have expanded the horizon of computational mechanics and scientific computing beyond what the conventional computational methods can offer. Applications to plasticity, localization and fracture modeling using the proposed methods will be presented.

CV

J. S. Chen is the William Prager Chair Professor and Distinguished Professor of Structural Engineering Department, Mechanical & Aerospace Engineering Department, and the Founding Director of Center for Extreme Events Research at UC San Diego. Before joining UCSD in 2013, he was the Chancellor’s Professor of UCLA Civil & Environmental Engineering Department, Mechanical & Aerospace Engineering Department, and Mathematics Department, where he served as the Department Chair of Civil & Environmental Engineering during 2007-2012. J. S. Chen’s research is in computational mechanics and multiscale materials modeling with specialization in the development of meshfree methods. He is the Past President of US

Association for Computational Mechanics (USACM) and the Past President of ASCE Engineering Mechanics Institute (EMI). He has received numerous awards, including the Raymond D. Mindlin Medal of ASCE Engineering Mechanics Institute, the Computational Mechanics Award from International Association for Computational Mechanics (IACM), the Grand Prize from Japan Society for Computational Engineering and Science (JSCES), the Ted Belytschko Applied Mechanics Award from ASME Applied Mechanics Division, the Belytschko Medal from U.S. Association for Computational Mechanics (USACM), the Computational Mechanics Award from Japan Association for Computational Mechanics (JACM), the ICACM Award from International Chinese Association for Computational Mechanics (ICACM), among others. He is the Fellow of USACM, IACM, ASME, EMI, SES, ICACM, and ICCEES. He received BS (Civil Engineering) from National Central University, Taiwan, and MS and PhD (Theoretical & Applied Mechanics) from Northwestern University.